TRENTWOOD PLANT MONITORING WELL DATA EVALUATION

August, 1980

by: SWEET, EDWARDS & ASSOCIATES, INC.
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Landfill Envelope

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Background and Introduction

As part of our on-going assistance to Kaiser-Trentwood regarding solid waste and waste management, we have developed the following analysis of the data accumulated to date from the plant site monitoring wells. The wells were installed to our specifications in September and October, 1979. Water table measurements and sampling for nitrate and chloride concentrations have been carried out since that time. Hydrologic and water quality data needs were developed to determine if contamination of the "sole source" aquifer is occurring as a result of historic and/or current disposal practices at the plant. Recommendations for additional monitoring, remedial actions and evaluation of those actions are included.

Hydrogeology

The Spokane-Rathdrum Prairie Aquifer has been declared a "sole source" of water for the Spokane area. It is a highly productive aquifer, capable of transmitting large volumes of ground water to wells. The transmissivity of the aquifer also makes it susceptible to contamination from surface and/or subsurface sources.

As part of a program to evaluate the aquifer conditions below the Trentwood Plant, Kaiser-Trentwood recently installed five monitoring wells at the plant site, see Figures 1, 2, 3 and appended boring logs. The boring logs show the unsaturated zone below the plant to be generally poorly sorted sands and gravels. Gravel with some clay content is reported at or just above the water bearing zone in several borings. In fact, the water level reportedly rose in four of the five wells as they were deepened, indicating at least partially confining conditions. This confined condition is important in that artesian aquifers are much less likely to be contaminated than water table aquifers since they have a less permeable, i.e., confining, bed above the water bearing unit and have a potential gradient toward the surface. Note, however, that the confining units in the vicinity of Kaiser-Trentwood are not continuous as shown by the well logs, and at least some of the contaminants infiltrating from the surface and accumulating above these lenticular units could eventually be expected to "spill over" to the stratigraphically lower units. The extent of this "spill over" can not be quantified given the available data base and would require extensive drilling and very detailed subsurface control.

The extremely high hydraulic conductivity of the aquifer is well documented, e.g., $T = 2.5 \times 10^6$ ft^2/day, in the vicinity of Trentwood. These high transmissivity values reflect the nature of the gravelly aquifer. Pore velocities are reported at 60 to 90 ft/day and result in a potential for rapid movement of ground-water coincident contaminants in the aquifer.

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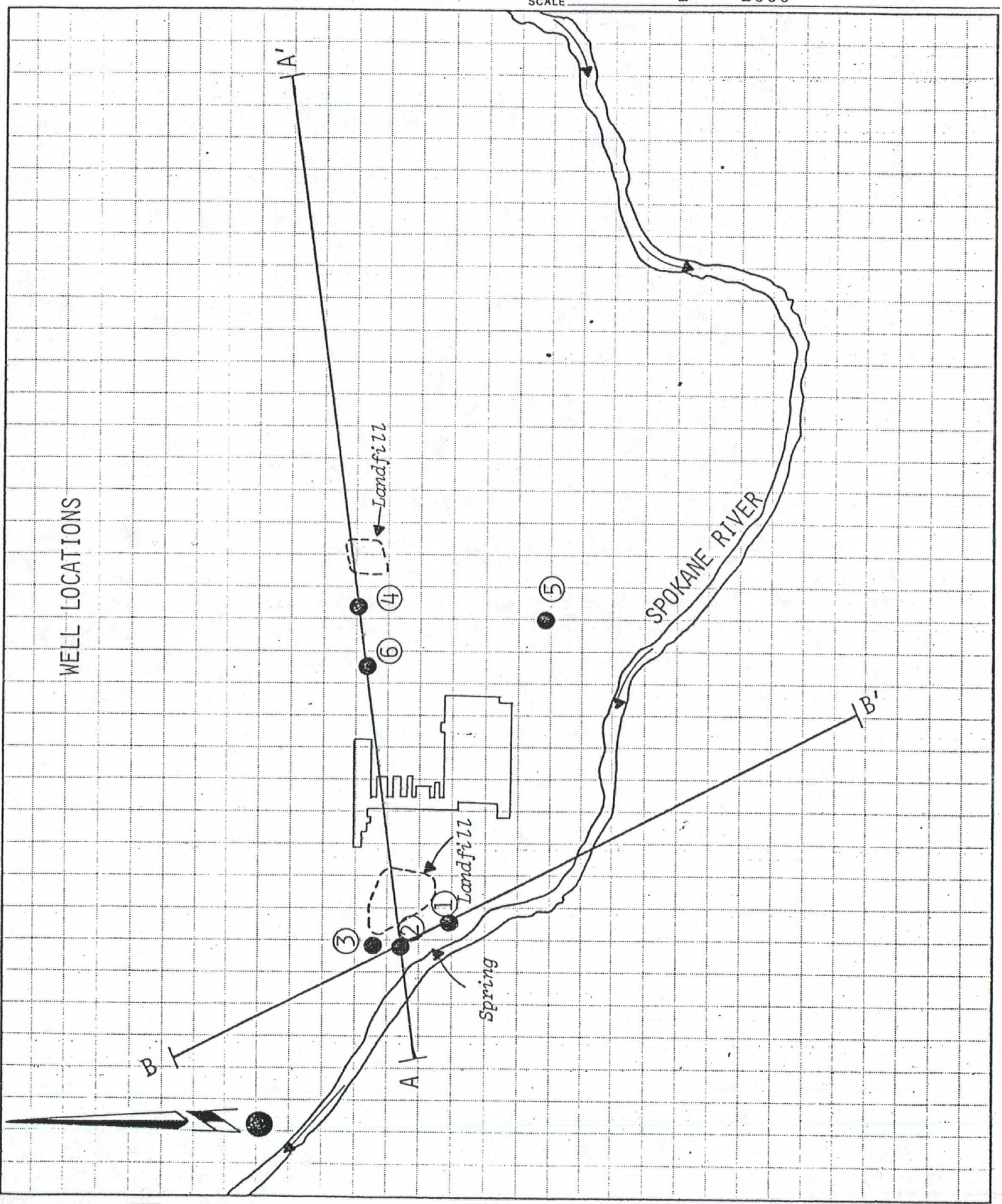
JOB Kaiser-Trentwood FIGURE 1
SHEET NO. 1 OF 1
CALCULATED BY CEW DATE 1-15-80
CHECKED BY HRS DATE 3-04-80
SCALE 1" = 2000'



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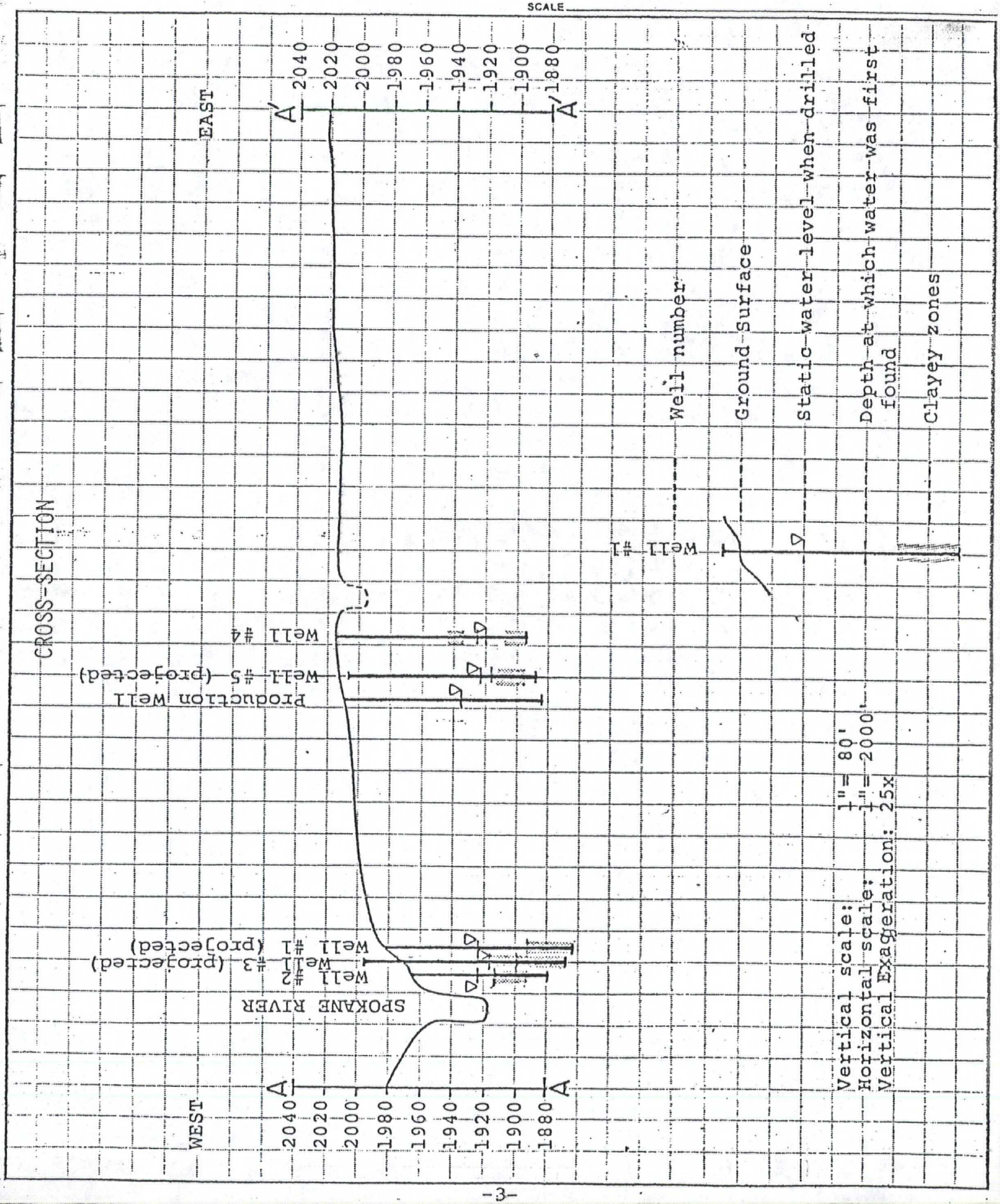
JOB

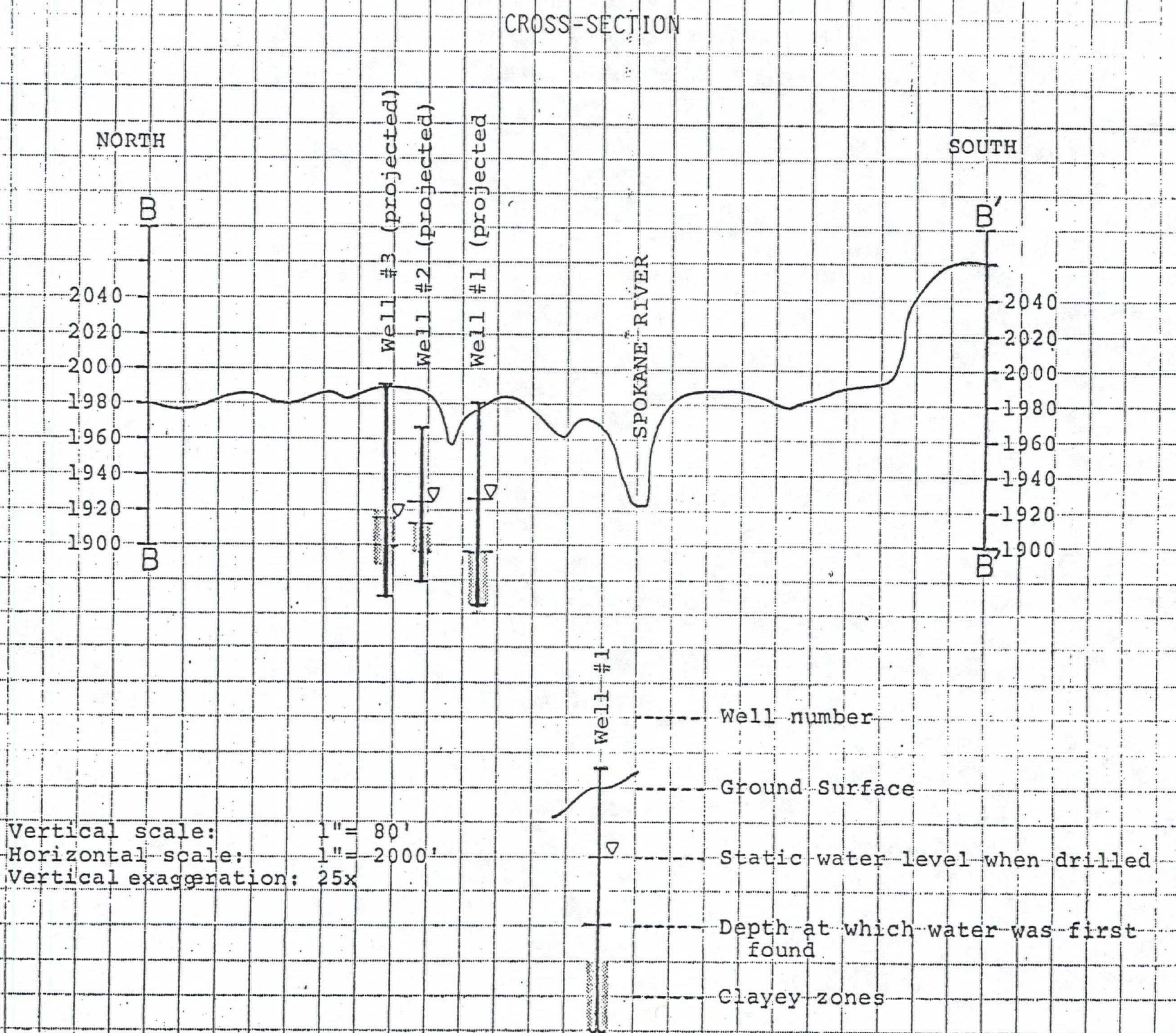
SHEET NO. 2 OF 3

CALCULATED BY DATE

CHECKED BY DATE

SCALE





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JOB Kaiser-Trentwood

SHEET NO. 3 OF 3

CALCULATED BY ______ DATE ______

CHECKED BY ______ DATE ______

SCALE ______

FIGURE 3

The general ground-water flow system at the Trentwood Plant is complicated by the adjacent Spokane River. Review of the various regional hydrogeologic studies of the Spokane-Rathdrum Prairie Aquifer indicate that the Spokane River is generally a losing stream above Sullivan Road and a gaining stream below the road. Some reports discuss seasonal reversals in the gradient, i.e., flow into and away from the Spokane River.

Figures 2 and 3 and the appended boring logs show the relative elevations of the water bearing zones and the potentiometric surface, at the time the monitoring wells were installed as well as more recently. The water bearing zones are reportedly below the Spokane River elevation and even with the rise in the potentiometric surface with increased drilling depth, the potential gradient appeared to be away from the river between the months of October, 1979, and February, 1980, while more recent measurement on March 3, 1980, show that the gradient is generally toward the river at this time. Figures 4 and 5 show the approximate water table configuration during October, 1979, and May, 1980. These figures show the seasonal gaining and losing nature of the Spokane River. Comparison of well hydrographs for monitoring wells #1, #2 and #3, which are near the river, with the river hydrograph, Figures 6, 7 and 8, emphasize the intimate connection between the aquifer and this surface water.

The interdependence of the river and the aquifer is partially facilitated by the ability of the aquifer to transmit water. As described above, the Spokane aquifer is highly permeable and readily transmits large volumes of ground-water underflow. For example, the transmissivity value listed above (2.5×10^6 ft^2/day); the average gradient through the plant area 0.0007 to 0.001 ft/ft; and a unit aquifer width of 500 ft, i.e., the approximate width of the East Landfill, would transmit 6.9 to 10.9 million gal/day of ground-water underflow. These large volumes of underflow have a carrying capacity and/or dilution potential much like a large stream even for conservative water coincident contaminants, i.e., those not generally filtered, adsorbed or attenuated except via dilution. We should note that our hydrologic and water quality monitoring deal with only that amount of underflow susceptible to interception by the monitoring wells and the plant production well. This is 10 to 20 percent of the total underflow assuming that the aquifer is about 280 feet thick as reported in earlier studies. It is however, the portion of the aquifer most heavily utilized.

Recharge to the aquifer below the plant is primarily from inflow, surface and ground water, as outlined above. However, infiltrating precipitation is also a contributor to the ground water. Recharge above the East and West Landfill sites is dependent upon precipitation; soil moisture retention and evapotranspiration. The East Landfill has effectively no soil overlying the filled areas and a large portion of the pit is

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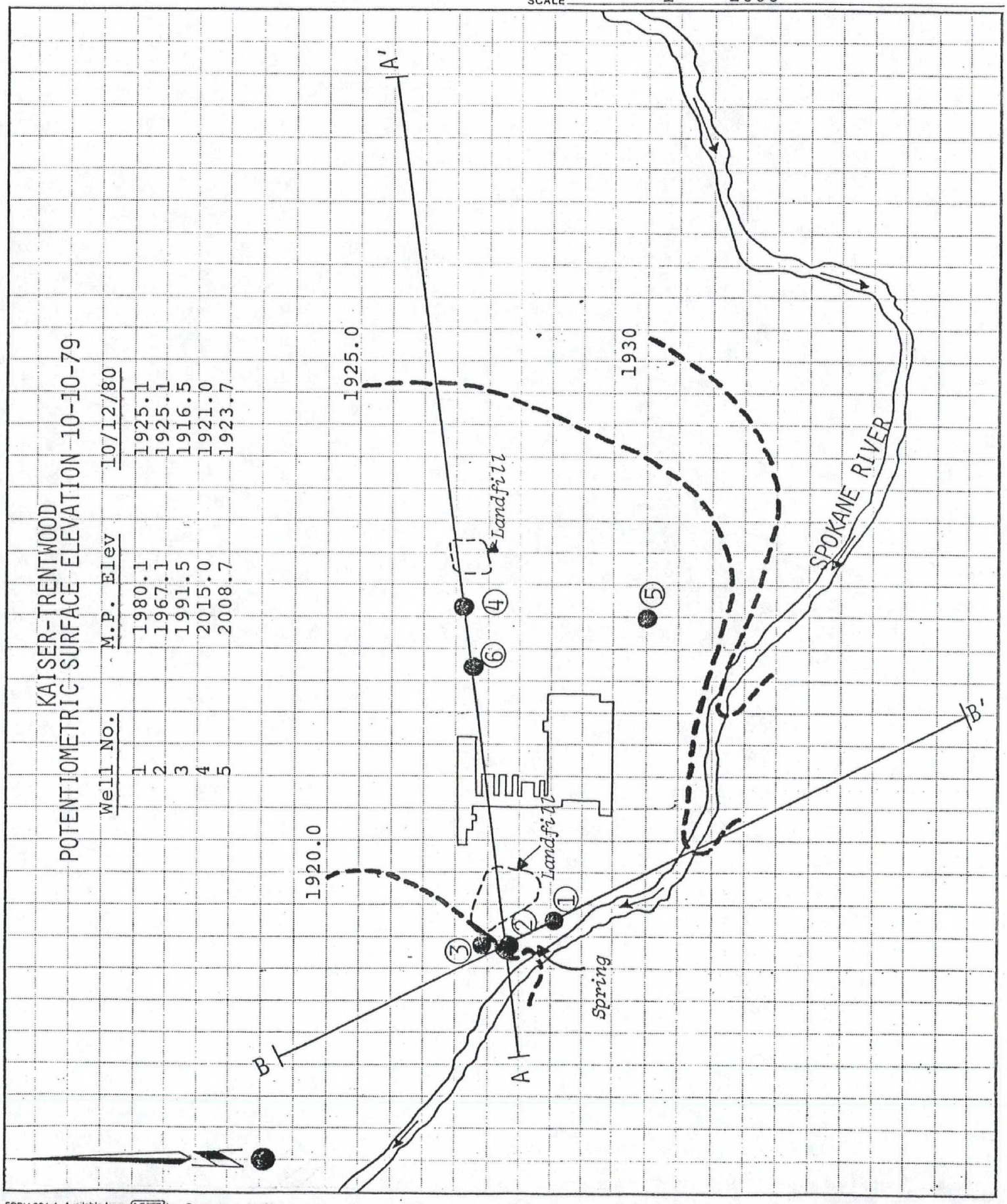
JOB Kaiser-Trentwood FIGURE 4
SHEET NO. 1 OF 1
CALCULATED BY CEW DATE 1-15-80
CHECKED BY HRS DATE 3-04-80
SCALE 1" = 2000'



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JOB Kaiser-Trentwood FIGURE 5
SHEET NO. 1 OF 1
CALCULATED BY CEW DATE 1-15-80
CHECKED BY HRS DATE 3-04-80
SCALE 1" = 2000'

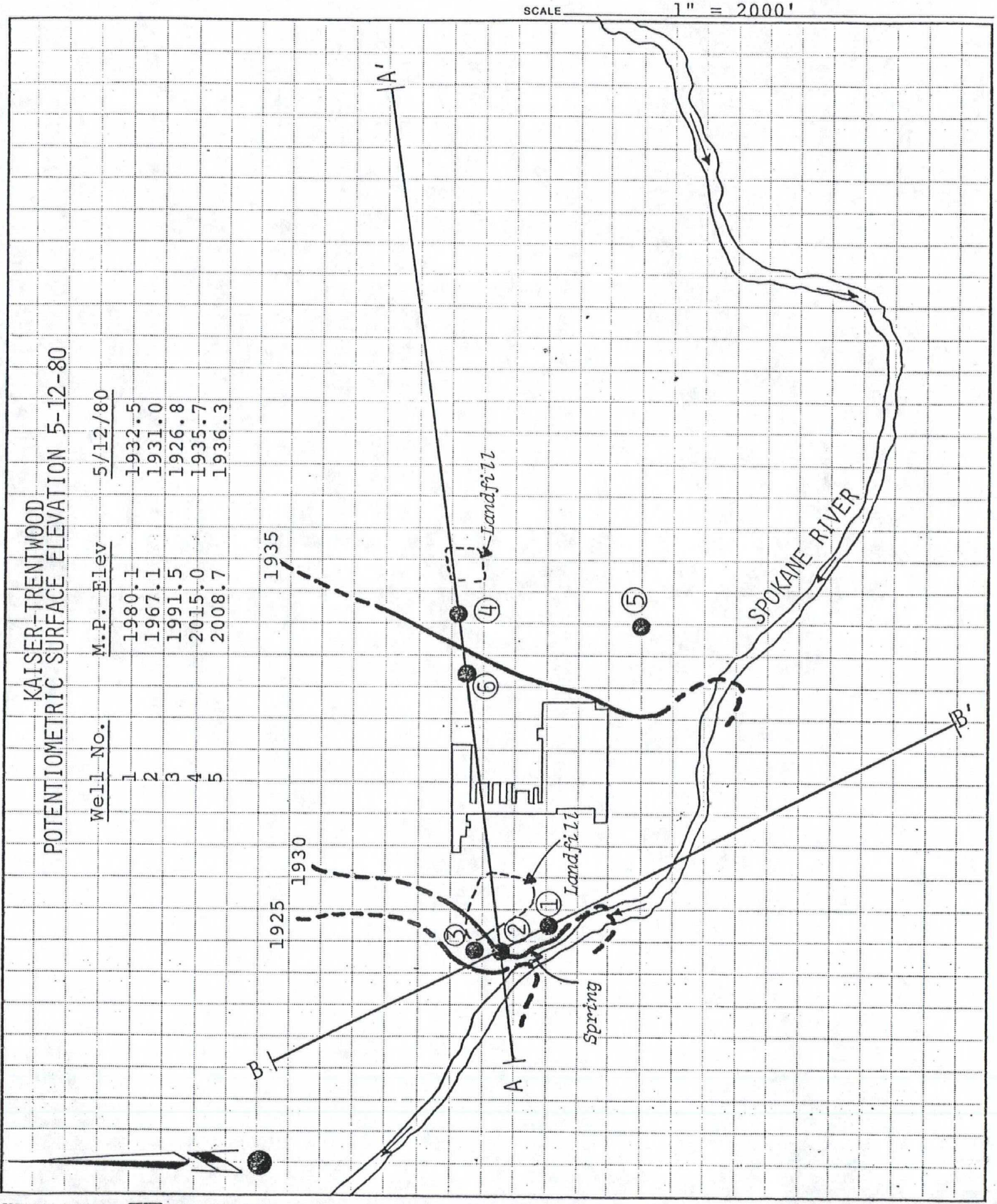
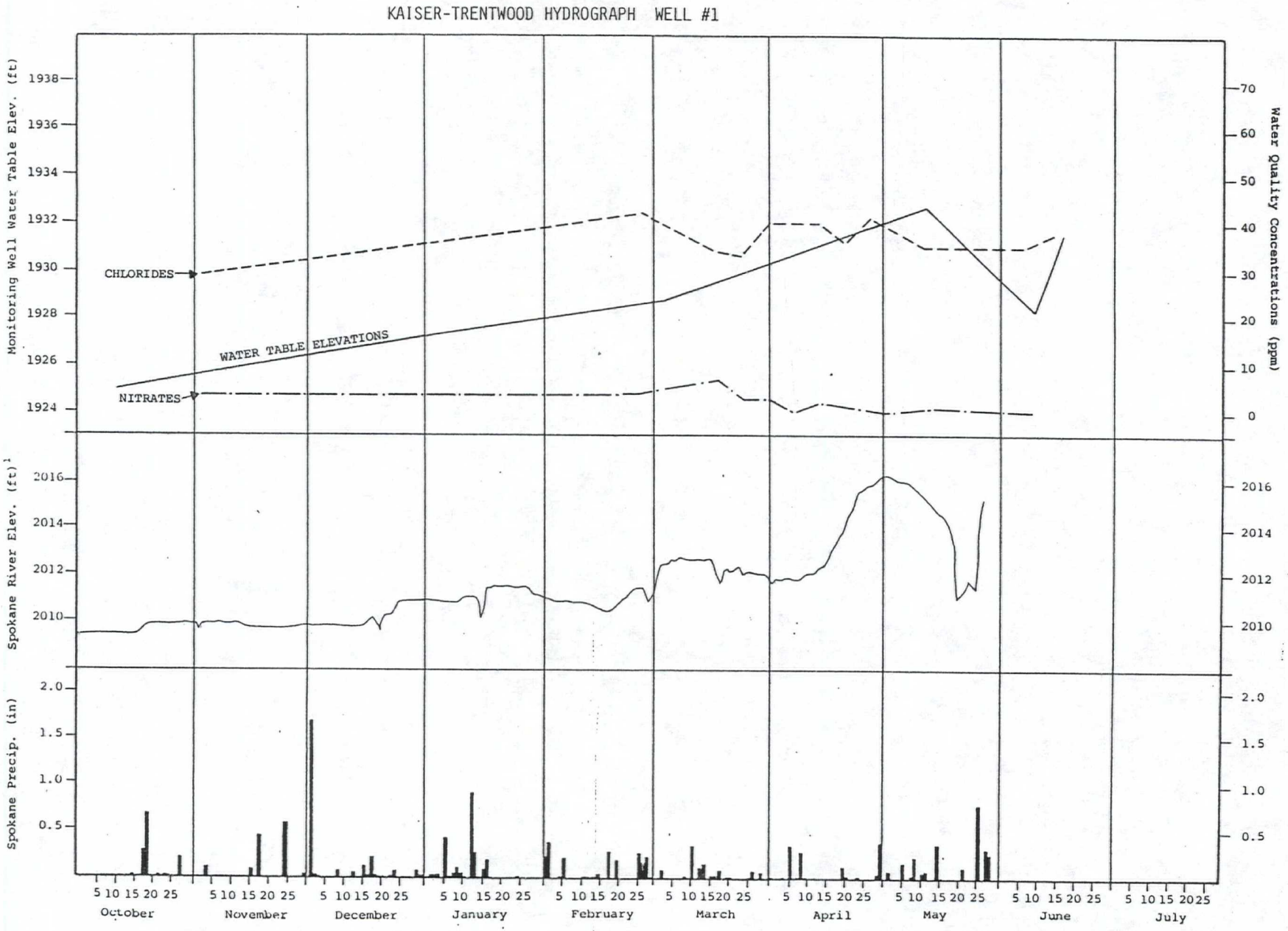


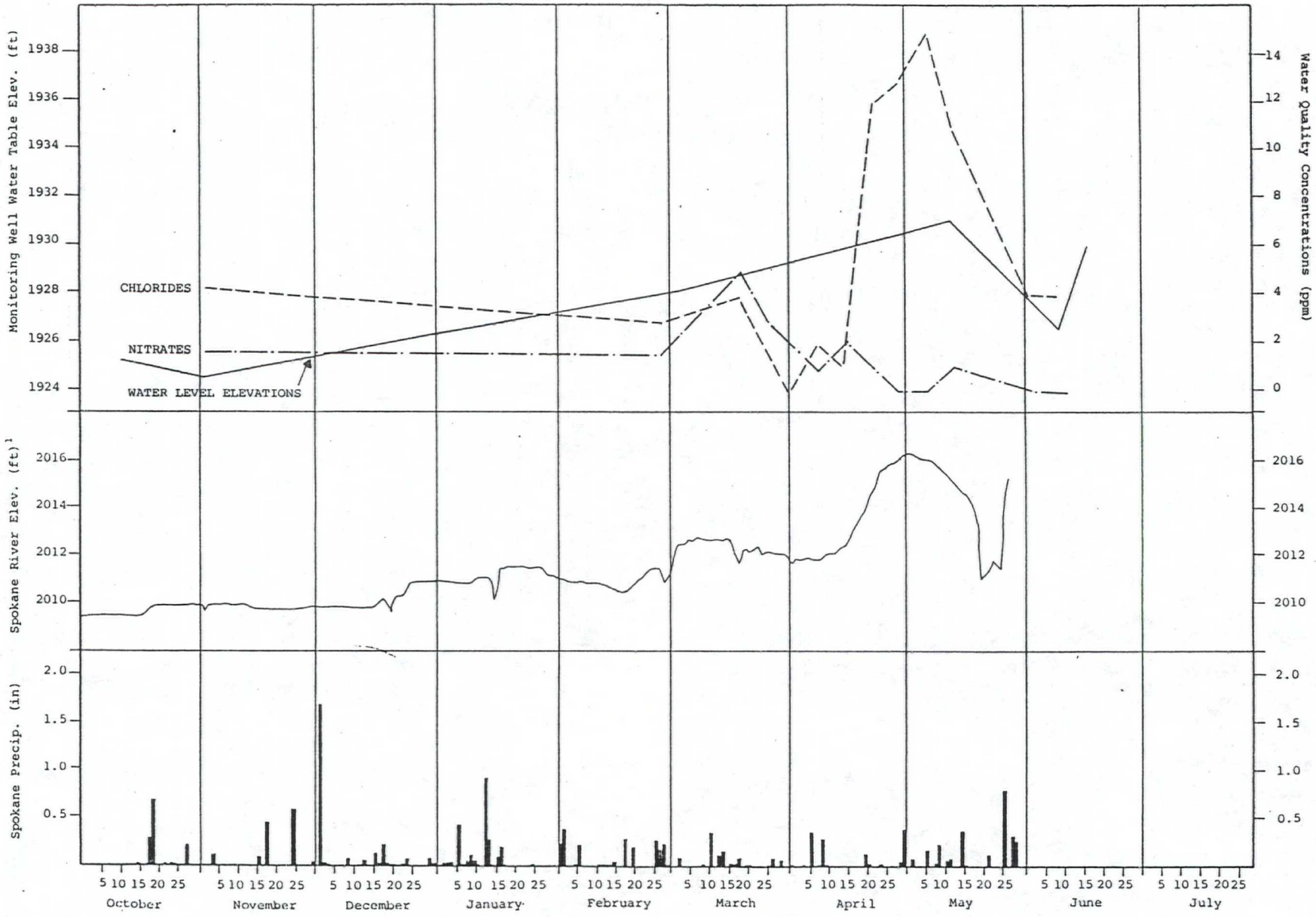
FIGURE 6



[1]From U.S.G.S. Gage above Liberty Bridge, between river miles 93 & 94. Gage datum is 2000.0 feet above m.s.l.

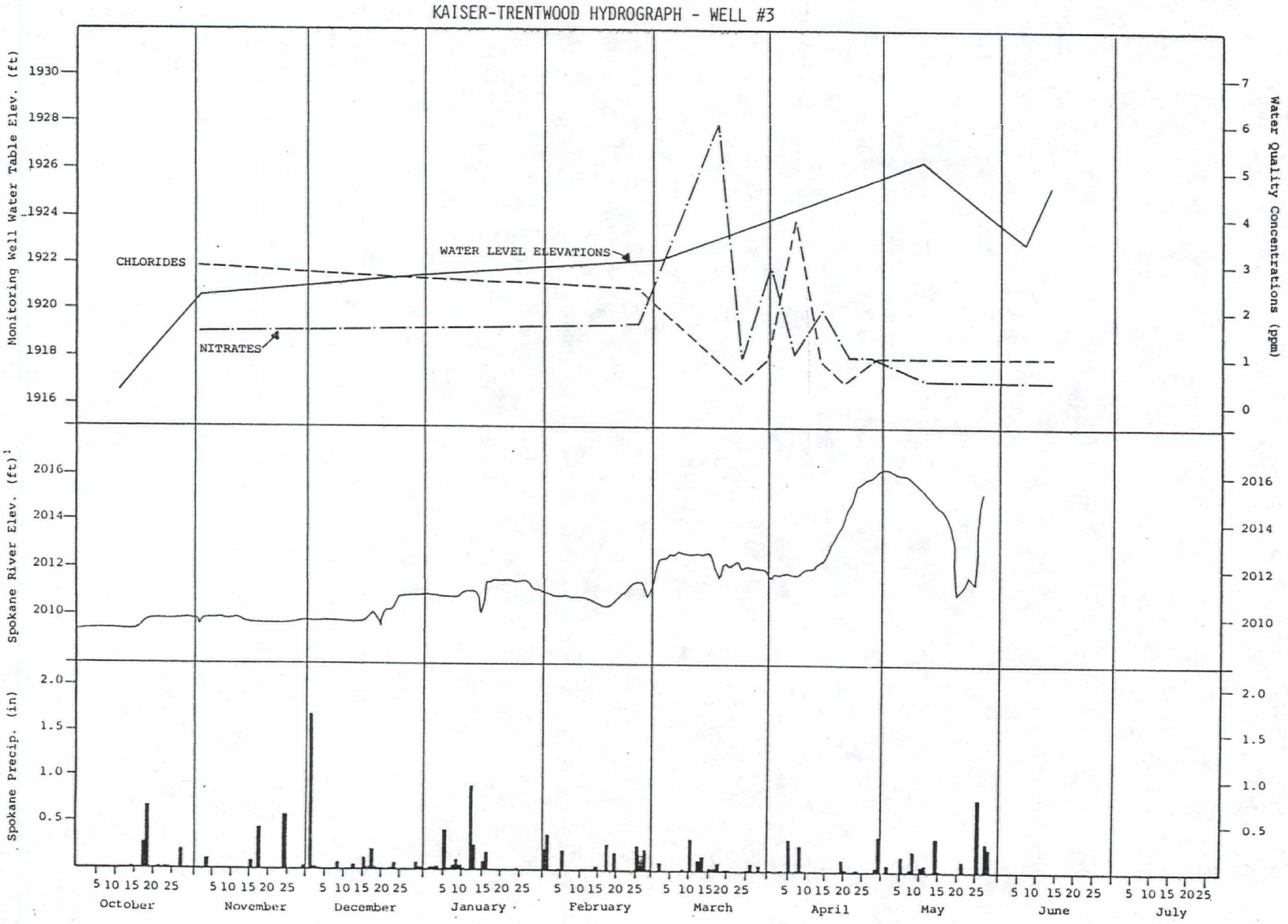
FIGURE 7

KAISER-TRENTWOOD HYDROGRAPH - WELL #2



[1]From U.S.G.S. Gage above Liberty Bridge, between river miles 93 & 94. Gage datum is 2000.0 feet above m.s.l.

FIGURE 8



[1]From U.S.G.S. Gage above Liberty Bridge, between river miles 93 & 94. Gage datum is 2000.0 feet above m.s.l.

an open catchment area. The trench fill operation at the West Landfill also has very little or no soil cover. Even where there has been no disturbance or excavation of the topsoil at the plant, there is only a shallow veneer of top soil. That top soil has a reported high permeability of greater than 10^{-4} cm/sec and a very low soil moisture holding capacity. These conditions result in almost no surface runoff and a minimum of actual water loss to evapotranspiration. The filled and open pit area at the East Landfill is estimated to have a moisture holding capacity of one inch, which may be a high estimate given the topography, centripetal drainage, absence of fine grained soil and paucity of vegetation. Under these conditions, infiltration and downward percolation of nearly 10 in/yr or about 1.5 million gal/yr is calculated. Because of seasonally frozen ground and snow accumulation, much of this downward "flush" takes place rapidly during the early spring thaw.

Water Quality

Extensive areawide ground-water sampling and testing was carried out during development of the Spokane-Rathdrum Prairie "sole source" aquifer evaluation. This data has shown background nitrate and chloride levels at the on-site production well to be 1.4 to 5.4 mg/l and 3 to 60 mg/l, respectively, see Appended STORET data. The Trentwood Plant has had a history of seasonally, i.e., spring, elevated nitrate and chloride levels in its production wells. Nitrate has periodically exceeded the Primary Drinking Water Standard of 10 mg/l nitrate-nitrogen (NO_3-N). This situation is a major concern and essentially responsible for this analysis.

Chloride and NO_3-N data collected from November 1, 1979, through June 6, 1980, at the five on-site wells is included in Tables 1 and 2. Figures 6 through 10 also show graphically the relationships between precipitation, changes in river stage and water table elevation at each of the monitoring wells.

Only one winter season of integrated water quality/hydrology data is available but this indicates some cause and effect relationships. The location of the East Landfill upgradient from well #4 and the production well makes it a prime potential source of increased contamination of the aquifer and consequently the wells. Some black dross was reportedly disposed of in this site in earlier years. As reported in our April, 1978, preliminary evaluation the black dross reportedly includes:

Sodium chloride (NaCl)	39%
Potassium chloride (KCl)	19%
Nitrides and Carbides (Al_2N_3; Al_4C_3)	1%
Cryolite ($NaAl_2F_6$ or KAL_2F_6)	2%
Aluminum oxide (Al_2O_3)	35%
Aluminum (Al)	4%

TABLE 1

CHLORIDES (mg/l)

DATE	WELL #1	WELL #2	WELL #3	WELL #4	WELL #5
11/01/79	29.9	4.7	3.0	5.1	1.4
02/25/80	43.8	2.9	2.5	-	-
03/11/80	-	-	-	0.0	4.0
03/17/80	35.0	4.0	1.0	-	-
03/18/80	-	-	-	7.0	0.0
03/24/80	34.0	2.0	0.0	-	-
03/25/80	-	-	-	4.0	0.0
03/31/80	41.0	0.0	1.0	-	-
04/01/80	-	-	-	4.0	0.0
04/07/80	41.0	2.0	4.0	-	-
04/08/80	-	-	-	4.0	0.0
04/14/80	41.0	1.0	1.0	-	-
04/15/80	-	-	-	3.0	0.0
04/21/80	37.0	12.0	0.0	-	-
04/24/80	-	-	-	7.0	2.0
04/28/80	42.0	13.0	1.0	-	-
04/29/80	-	-	-	109.0	1.0
05/05/80	39.0	15.0	3.0	161.0	2.0
05/12/80	36.0	11.0	-	-	-
05/13/80	-	-	-	74.0	1.0
05/30/80	-	-	-	33.0	6.0
06/02/80	25.0	4.0	1.0	-	-
06/09/80	36.0	4.0	1.0	-	-
06/10/80	-	-	-	6.0	1.0

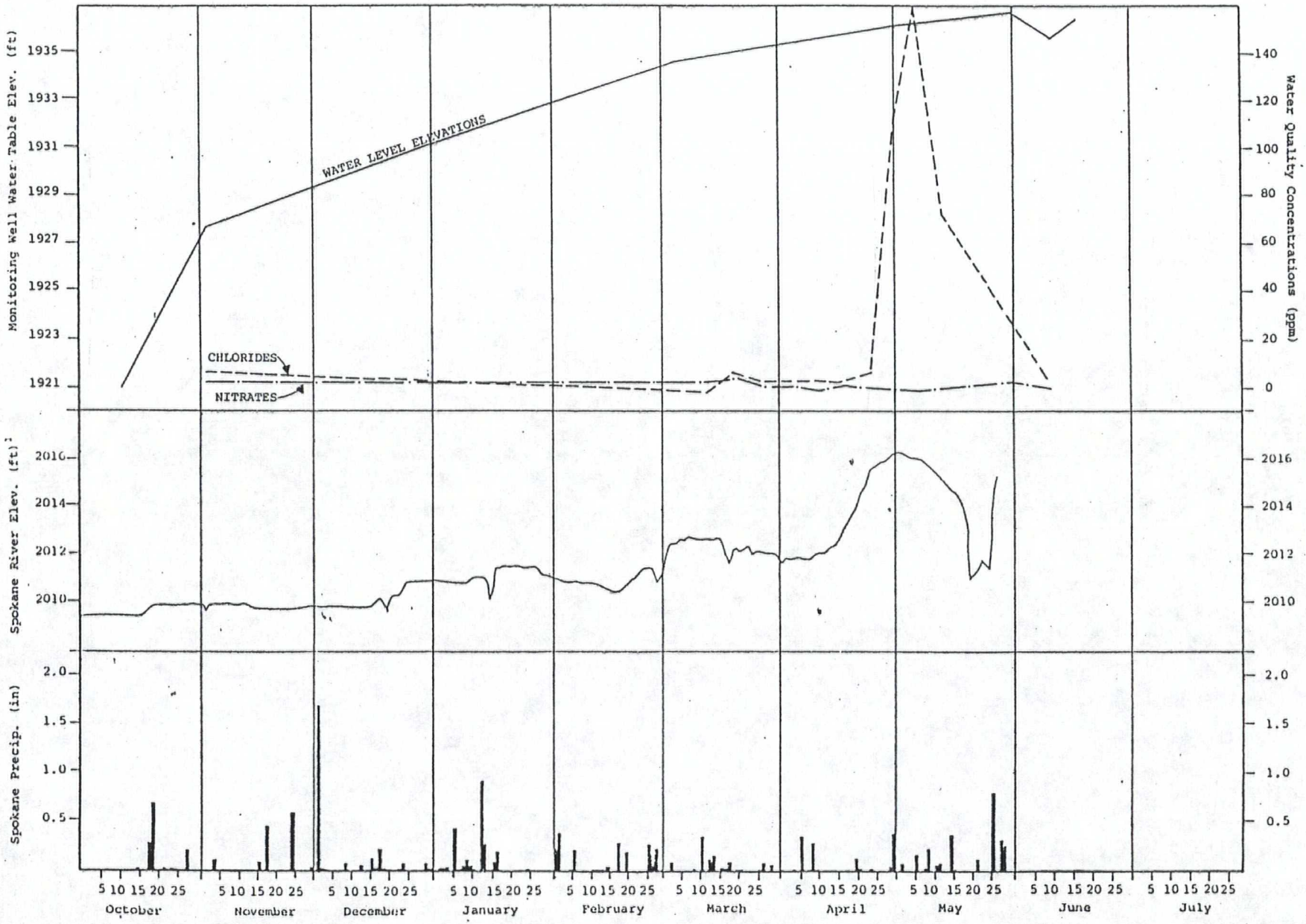
TABLE 2

NITRATES (ppm)

DATE	WELL #1	WELL #2	WELL #3	WELL #4	WELL #5
11/01/79	3.4	1.5	1.6	2.6	1.3
02/25/80	4.0	1.5	1.8	-	-
02/29/80	-	-	-	4.0	2.0
03/11/80	-	-	-	4.0	4.0
03/17/80	7.0	5.0	6.0	-	-
03/18/80	-	-	-	6.0	6.0
03/24/80	3.0	3.0	1.0	-	-
03/25/80	-	-	-	1.0	1.0
03/31/80	3.0	2.0	3.0	-	-
04/01/80	-	-	-	2.0	0.0
04/07/80	0.0	1.0	1.0	-	-
04/08/80	-	-	-	0.0	2.0
04/14/80	2.0	2.0	2.0	-	-
04/15/80	-	-	-	2.0	2.0
04/21/80	1.0	1.0	1.0	-	-
04/24/80	-	-	-	1.0	1.0
04/28/80	0.0	0.0	1.0	-	-
04/29/80	-	-	-	0.0	0.0
05/05/80	0.0	0.0	0.0	0.0	0.0
05/12/80	1.0	1.0	0.0	-	-
05/13/80	-	-	-	1.0	2.0
05/30/80	-	-	-	2.0	2.0
06/02/80	0.0	0.0	0.0	-	-
06/09/80	0.0	0.0	0.0	-	-
06/10/80	-	-	-	0.0	0.0

FIGURE 9

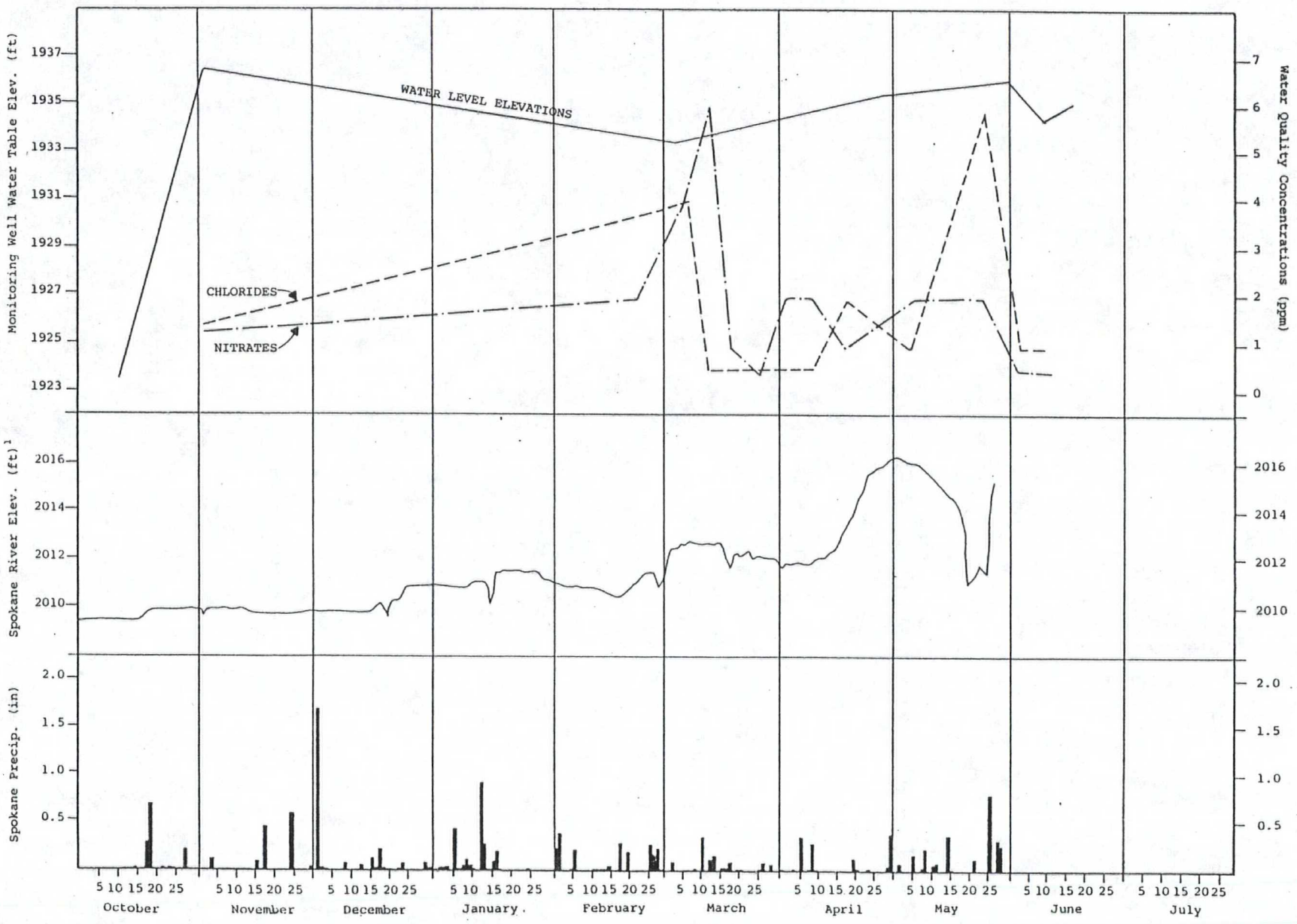
KAISER-TRENTWOOD HYDROGRAPH - WELL #4



[1]From U.S.G.S. Gage above Liberty Bridge, between river miles 93 & 94. Gage datum is 2000.0 feet above m.s.l.

FIGURE 10

KAISER-TRENTWOOD HYDROGRAPH - WELL #5



[1]From U.S.G.S. Gage above Liberty Bridge, between river miles 93 & 94. Gage datum is 2000.0 feet above m.s.l.

Chloride salts reportedly account for more than one-half of the dross blocks total weight. Chlorides are extremely soluble and small concentrations are easily measured in the laboratory. Chloride migrates relatively freely through the saturated zone, making it a good tracer for delineating zones of ground-water contamination. The secondary drinking water limit for chlorides, as established by E.P.A., is relatively high at 250 mg/l. Chlorides in drinking water are not generally harmful to humans until extremely high concentrations are reached, although they may be injurious to some people suffering from diseases of the heart or kidneys. Restrictions for drinking water chloride limits are generally based on palatability rather than health (McKee and Wolf, 1963). Roe (1978) reported that some taste problems had been experienced with water from the present on-site well, see Appendix A and later discussion.

A small percentage of the dross is reportedly aluminum carbides and nitrides. Aluminum carbides react with water to form aluminum hydroxide and methane gas. This gas poses no threat to ground-water quality and the aluminum hydroxide is a doubtful threat. On the other hand, nitride ions are unstable in aqueous solution, since they react with water to form ammonia and hydroxide ions. Note: The distinct ammonia odor experienced in the presence of the dross. Nitrification of ammonia (NH_4) to nitrite (NO_2) and thence to nitrate (NO_3) takes place relatively rapidly under oxidizing conditions. These oxidizing conditions are common to the unsaturated zone between the land surface and the water table. Denitrification or a reduction in the nitrogen concentration can and probably does take place to a certain extent through the volatilization of ammonia and its loss to the atmosphere. Nitrate, like chloride, is an excellent tracer for delineation of zones of ground-water contamination. They are soluble and travel freely through the saturated zone via the ground-water flow systems and are primarily attenuated by hydrodynamic dispension and dilution.

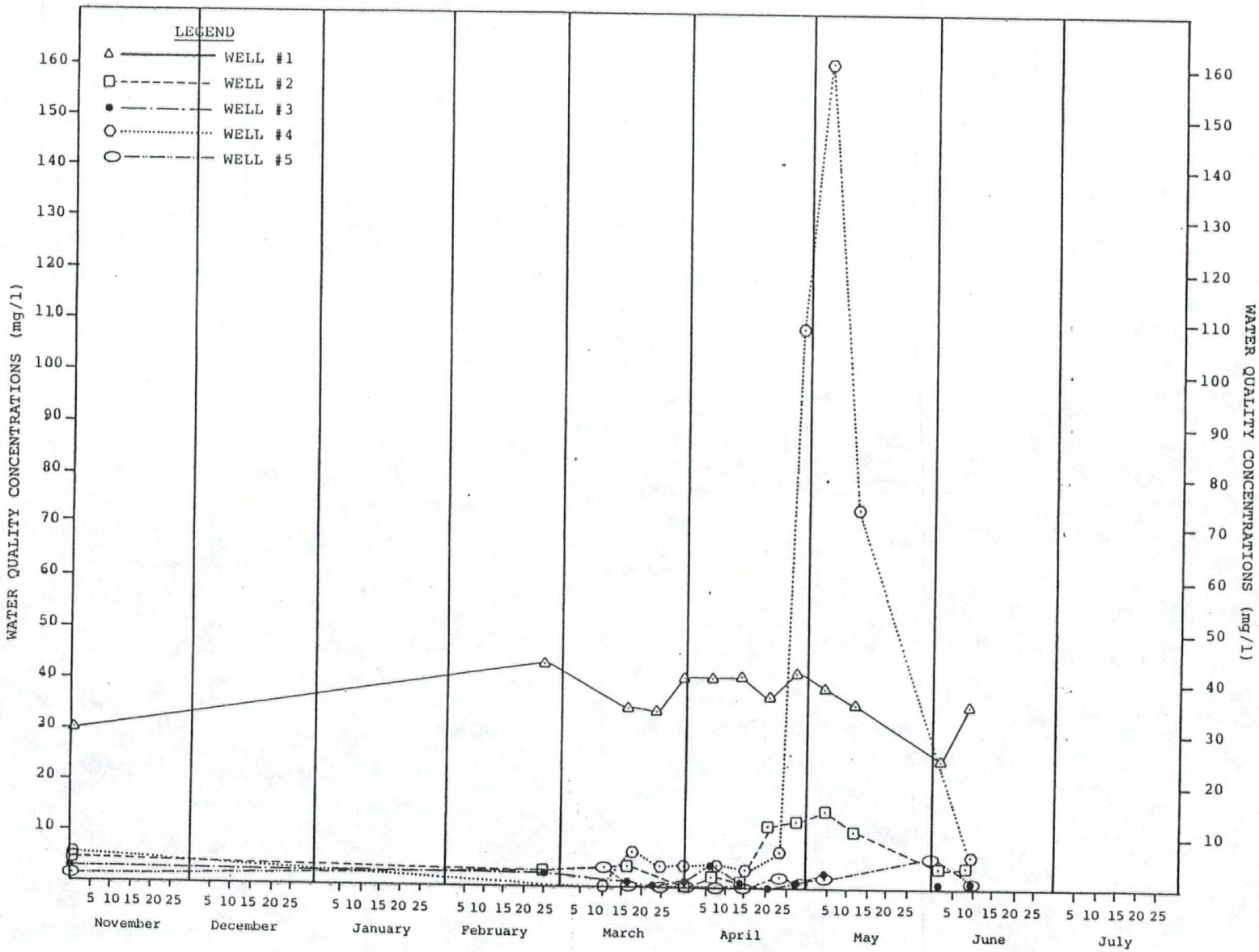
On the other hand the West Landfill reportedly includes little or no dross in its waste. It is significant that there is less increase in the chloride concentration at wells #1, #2, #3 and #5 than at well #4, see Figure 11. Well #1 is somewhat higher than Nos. 2, 3 and 5 and this may be due to subsurface channelization away from the West Landfill or limited seepage from the lagoon site. Note that well #1 also registered a slightly higher NO_3-N concentration than the other sites, see Figure 12.

During this sampling period, none of the monitoring wells reached the previously high concentrations recorded for the production well or the Primary Water Standard for NO_3-N, i.e., 10 mg/l. Note that these same limits apply to the current Resource Conservation and Recovery Act(RCRA) limits for allowable ground-water degradation at the edge of the waste site.

The uniform increase in NO_3-N concentrations at all wells,

FIGURE 11

CLORIDES ALL WELLS



see Figure 12, including those near the Spokane River as well as #4 downgradient from the East Landfill and #5 away from all potential Trentwood Plant sources indicates that seasonally infiltrating recharge is the prime driving force for contamination of the upper portion of the aquifer. Chlorides are a major contaminant in the East Landfill and increased dramatically only at #4 indicating that the spring melting of frozen ground and flushing of the recharge through the waste results in a seasonal contamination of the aquifer and consequently the downgradient production well.

One complication to the above interpretation is that a number of off-site contamination sources may exist. Spills and leaks have been documented at the industrial complex east of the plant and open piles of dross at an aluminum recovery operation southeast of the site may contribute to the generally higher concentrations of NO_3-N and Cl at the Trentwood Plant as opposed to the Industrial Park, see Appendix B STORET data.

Potential Actions

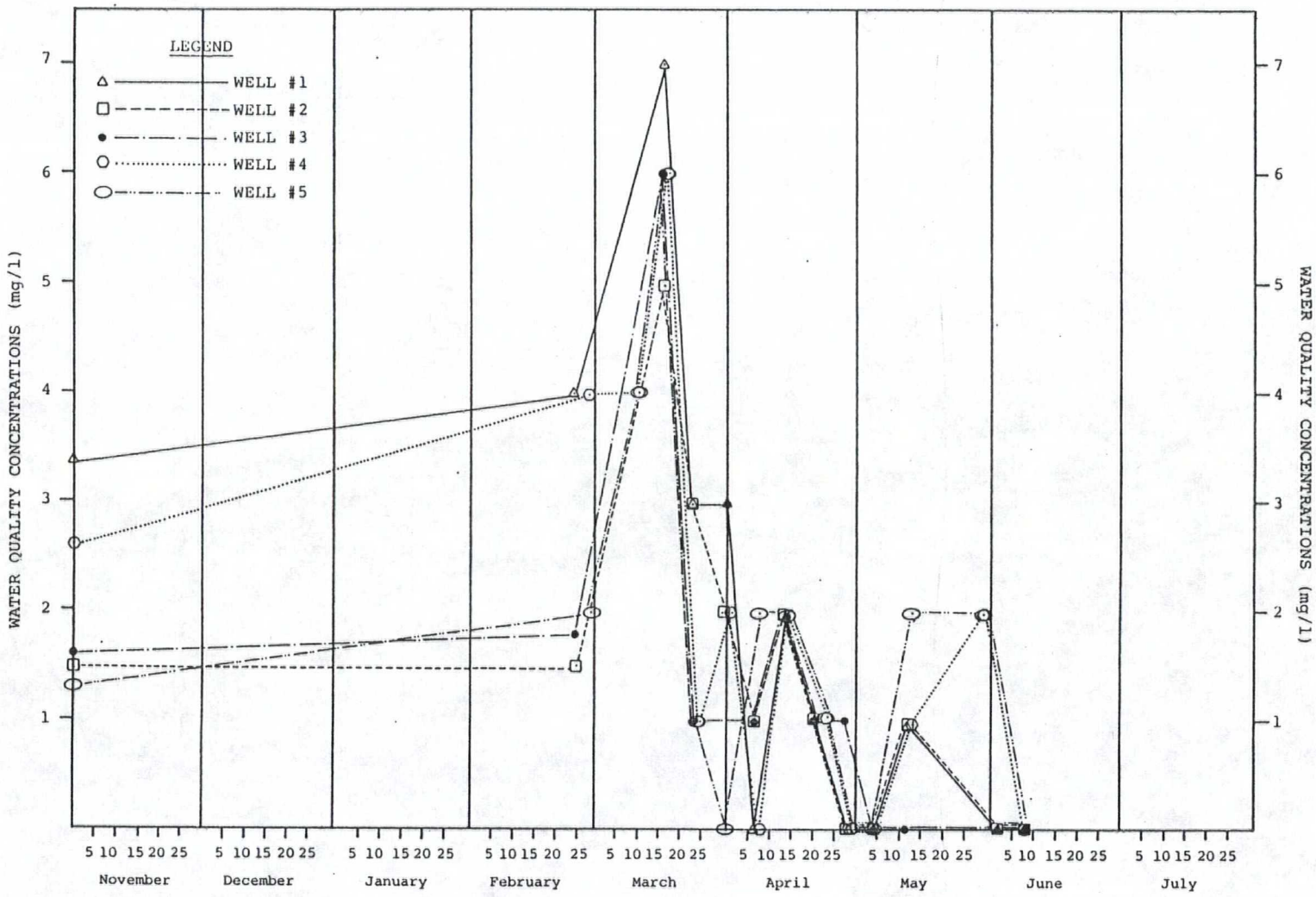
Efforts to minimize the generation of leachate and consequently ground-water contamination at the on-site facilities are complicated by the recent adoption of the Resource Conservation and Recovery Act (RCRA). RCRA has established a list of "hazardous wastes"(EHW) which is lengthy and appended regularly. If wastes having a hazardous designation are included in the East and/or West Landfills, strict closeout requirements are a possibility. Assuming no EHW materials are present, the currently on-going RCRA inventory of open dumps will probably eventually close both landfills for either of two reasons: 1) they overlie a principal or sole source aquifer, and 2) water quality data at the production well has exceeded 10 mg/l NO_3-N which is the allowable limit at the waste boundary.

If the concentrations of NO_3-N can be maintained below the 10 mg/l level, not only will the production well remain a viable source but the landfill may be less susceptible to close scrutiny. Therefore, an improved moisture routing program to minimize the volume of water infiltrating into and percolating through the waste is suggested. This program would require minimum action of sloping or grading the area above the waste, placing a low permeability clay cover and finally a soil cap to maximize soil moisture retention and minimize the infiltration. Suitable vegetation to stabilize the soil cover and maximize evapotranspiration is suggested. A similar cover program at the West Landfill is suggested. However, the absence of a downgradient user such as the plant production well may justify less stringent closeout procedures at that site.

Note that the above conclusions and recommendations are

FIGURE 12

NITRATES ALL WELLS



based on the data collected over the past year. Comparison of our local water table map with older published regional maps indicates that the water table elevation or potentiometric surface observed this winter and spring are comparable to earlier years. Without a lengthy on-site period of record we cannot definitely say that infiltrating precipitation is the sole cause of the increases in contamination. The data available to date does support this conclusion. If conditions other than those noted in this report are observed, we should be notified in order to reconsider and perhaps revise our conclusions and recommendations.

APPENDIX A

MONITORING WELL BORING LOGS

CONTRACTOR American Drilling and Development, Inc.

DRILLER _____ HELPER _____

INSPECTOR _____ LOGGER _____ (Soil) _____ (Rock)

DATE: HOLE BEGUN 9/24/79 CASING PULLED _____ LOG _____ (Soil) _____ (Rock)

PROJ. NO. _____ BORING NO. 1 SH 1 OF 2

PROJ. NAME Kaiser Aluminum Trentwood Works

LOCATION Spokane (NE¼ NE¼ Sect 10 T25N R 44E)

SURF. EL. _____ ROCK EL. _____ TD 115'

Casing Piezometer Record	DEPTH (FT.)	Stratig.	SOIL SAMPLE RECORD: Samp. No.	Blows per 6"	Samp. Type	Progress (Date)	DRILLING RECORD: Type Bit	Run No.	No. of Seg.	Recov (Ft.)	% Rec	RQD	INSPECTOR'S REMARKS: Pocket penetrometer, water loss, artesian cond., caving, void, etc.
6" Casing	0												
	2												
	25												
	50												Static water level at completion of boring - 55'
Perforated	75												
6" Ca. Perforated	85												Water first encountered
	100												

GEOLOGIST'S LOG

TOP SOIL

GRAVEL AND BOULDERS

GRAVEL SOME SAND

GRAVEL, SOME CLAY SEAMS

Show diameter, depth casing(s), depth perforations piezometer. Indicate method advancing hole through soil.

Well diameter

Diameter (s) Sampler (s) _____

Weight Sampler Hammer _____ Drilling Fluid Soil _____ Rock _____

Free Drop Sampler Hammer _____

SWEET, EDWARDS & ASSOCIATES, INC.

GROUND WATER RECORD

Depth to Water	Time	Date	Depth of Casing

CONTRACTOR _____

DRILLER _____ HELPER _____

INSPECTOR _____ LOGGER _____ (Soil) _____ (Rock) _____

DATE: HOLE BEGUN _____ CASING PULLED _____ LOG _____ (Soil) _____ (Rock) _____

PROJ. NO. _____ BORING NO. 1 SH 2 OF 2

PROJ. NAME Kaiser Aluminum Trentwood Works

LOCATION _____

SURF. EL. _____ ROCK EL. _____ TD _____

Casing & Piezometer Record	DEPTH (FT.)	Stratig.	SOIL SAMPLE RECORD: Sample No.	SOIL SAMPLE RECORD: Blows per 6"	SOIL SAMPLE RECORD: Sample Type	Progress (Date)	DRILLING RECORD: Type Bit	DRILLING RECORD: Run No.	DRILLING RECORD: No. of Seg.	DRILLING RECORD: Recov (Ft.)	DRILLING RECORD: % Rec	DRILLING RECORD: RQD	INSPECTOR'S REMARKS: Pocket penetrometer, water loss, artesian cond., caving, void, etc.	GEOLOGIST'S LOG
Perforated 6" Ca.	100													(continued)
														GRAVEL, SOME CLAY SEAMS
	115													Boring completed at 115 feet
	125													
	150													
	175													
	200													

A-2

⊛ Show diameter, depth casing(s), depth perforations piezometer. Indicate method advancing hole through soil.

Diameter (s) Sampler (s) _____

Weight Sampler Hammer _____ Drilling Fluid Soil _____ Rock _____

Free Drop Sampler Hammer _____

SWEET, EDWARDS & ASSOCIATES, INC.

GROUND WATER RECORD

Depth to Water	Time	Date	Depth of Casin

CONTRACTOR American Drilling & Development, Inc.
DRILLER _____ HELPER _____
INSPECTOR _____ LOGGER _____ (Soil) _____ (Rock)
DATE: HOLE BEGUN 9/28/79 CASING PULLED _____ LOG _____ (Soil) _____ (Rock)

PROJ. NO. _____ BORING NO. 2 SH 1 OF 1
PROJ. NAME Kaiser Aluminum Trentwood Works
LOCATION Spokane (SE¼ SE¼ Sect 3 T25N R 44E)
SURF. EL. _____ ROCK EL. _____ TD 90'

Casing Piezometer Record	DEPTH (FT.)	Stratig.	SOIL SAMPLE RECORD: Samp. No.	Blows per 6"	Samp. Type	Progress (Date)	DRILLING RECORD: Type Bit	Run No.	No. of Seg.	Recov (Ft.)	% Rec	RQD	INSPECTOR'S REMARKS: Packet penetrometer, water loss, artesian cond., caving, void, etc.	GEOLOGIST'S LOG
	0													TOP SOIL
	2													GRAVEL
	10													SMALL BOULDERS AND GRAVEL
	21													
	25													COARSE GRAVEL, SOME FINES
Perf-orated	42	▽												
A-3	50												Water first encounted at 53 feet	
	53													GRAVEL, CLAY CONTENT
Perf-orated	70													
Perf.	75													GRAVEL, WASHED
	83													CEMENTED SAND PEA GRAVEL
	90													
	100													Boring Completed at 90 feet

Show diameter, depth casing(s), depth perforations piezometer. Indicate method advancing hole through soil.

Diameter (s) Sampler (s) Well diameter is 6 inch
Weight Sampler Hammer _____ Drilling Fluid Soil _____ Rock _____
Free Drop Sampler Hammer _____

SWEET, EDWARDS & ASSOCIATES, INC.

GROUND WATER RECORD

Depth to Water	Time	Date	Depth of Casin

CONTRACTOR American Drilling and Development, Inc.
DRILLER _____ HELPER _____
INSPECTOR _____ LOGGER _____ (Soil) _____ (Rock)
DATE: HOLE BEGUN 10-5-79 CASING PULLED _____ LOG _____ (Soil) _____ (Rock)

PROJ. NO. _____ BORING NO. 3 SH 1 OF 2
PROJ. NAME Kaiser Aluminum Trentwood Works
LOCATION Spokane (SE¼ SE¼ Sect 3 T25N R 44E)
SURF. EL. _____ ROCK EL. _____ TD 120

Casing & Piezometer Record	DEPTH (FT.)	Stratig.	SOIL SAMPLE RECORD: Samp. No.	Blows per 6"	Samp. Type	Progress (Date)	DRILLING RECORD: Type Bit	Run No.	No. of Seg.	Recov (Ft.)	% Rec	RQD	INSPECTOR'S REMARKS (Pocket penetrometer, water loss, artesian cond., caving, void, etc.)	GEOLOGIST'S LOG
	0													GRAVEL AND SMALL BOULDERS
	25													GRAVEL COARSE AND SAND
	39													GRAVEL COARSE AND SMALL BOULDERS
	50													
	72	▽											Water first encountered at 90. feet	SOME BROWN CLAY AND GRAVEL
Perforated	75													
	90													BROWN CLAY AND GRAVEL
Perf	96													SAND COARSE GRAY CLAY AND GRAVEL
	100													

⊗ Show diameter, depth casing(s), depth perforations piezometer. Indicate method advancing hole through soil.

Well diameter is 6 inches

Diameter (s) Sampler (s) _____
Weight Sampler Hammer _____ Drilling Fluid Soil _____ Rock _____
Free Drop Sampler Hammer _____

SWEET, EDWARDS & ASSOCIATES, INC.

GROUND WATER RECORD

Depth to Water	Time	Date	Depth of Casing

IA-4

CONTRACTOR _____

DRILLER _____ HELPER _____

INSPECTOR _____ LOGGER _____ (Soil) _____ (Rock)

DATE: HOLE BEGUN _____ CASING PULLED _____ LOG _____ (Soil) _____ (Rock)

PROJ. NO. _____ BORING NO. 3 SH 2 OF 2

PROJ. NAME Kaiser Aluminum Trentwood Works

LOCATION _____

SURF. EL. _____ ROCK EL. _____ TD 120

Casing & Piezometer Record	DEPTH (FT.)	Stratig.	SOIL SAMPLE RECORD: Samp. No.	Blows per 6"	Samp. type	Progress (Date)	DRILLING RECORD: Type Bit	Run No.	No. of Seg.	Recov (Ft.)	% Rec	RQD	INSPECTOR'S REMARKS: Packet pressuremeter, water loss, artesian cond., caving, void, etc.	GEOLOGIST'S LOG
Perf	100													(Continued)
														SAND COARSE GRAY CLAY AND GRAVEL
Perf														
	125													Boring Completed at 120 feet
	150													
	175													
	200													

A-5

⊛ Show diameter, depth casing(s), depth perforations piezometer. Indicate method advancing hole through soil.

Diameter (s) Sampler (s) _____

Weight Sampler Hammer _____ Drilling Fluid Soil _____ Rock _____

Free Drop Sampler Hammer _____

SWEET, EDWARDS & ASSOCIATES, INC.

GROUND WATER RECORD

Depth to Water	Time	Date	Depth of Casin

CONTRACTOR American Drilling and Development, Inc.
DRILLER _____ HELPER _____
INSPECTOR _____ LOGGER _____ (Soil) _____ (Rock)
DATE: HOLE BEGUN 10/10/79 CASING PULLED _____ LOG _____ (Soil) _____ (Rock)

PROJ. NO. _____ BORING NO. 4 SH 1 OF 2
PROJ. NAME Kaiser Aluminum Trentwood Works
LOCATION Spokane (NE¼ NE¼ Sect 3 T25N R 44E)
SURF. EL. _____ ROCK EL. _____ TD 120'

Casing Piezometer Record	DEPTH (FT.)	Stratig.	SOIL SAMPLE RECORD: Samp. No.	Blows per 6"	Samp. Type	Progress (Date)	DRILLING RECORD: Type Bit	Run No.	No. of Sag.	Recov (Ft.)	% Rec	RQD	INSPECTOR'S REMARKS: Packer permeameter, water loss, artesian cond., caving, void, etc.	GEOLOGIST'S LOG
	0													
														GRAVEL AND BOULDERS
	23													
	25													COARSE GRAVEL
	48													
	50													BOULDERS
9-V	59													COARSE GRAVEL
Perf-orated	75													
	77													SOME BROWN CLAY AND GRAVEL
	79													
													Water first encountered at 89 feet	COARSE GRAVEL
	93													
Perf	100													GRAVEL SOME FINES (SAND)

⊛ Show diameter, depth casing(s); depth perforations piezometer. Indicate method advancing hole through soil.

Diameter (s) Sampler (s) Well diameter is 6 inches
Weight Sampler Hammer _____ Drilling Fluid Soil _____ Rock _____
Free Drop Sampler Hammer _____

SWEET, EDWARDS & ASSOCIATES, INC.

GROUND WATER RECORD

Depth to Water	Time	Date	Depth of Casing

CONTRACTOR _____

DRILLER _____ HELPER _____

INSPECTOR _____ LOGGER _____ (Soil) _____ (Rock)

DATE: HOLE BEGUN _____ CASING PULLED _____ LOG _____ (Soil) _____ (Rock)

PROJ. NO. _____ BORING NO. 4 SH 2 OF 2

PROJ. NAME Kaiser Aluminum Trentwood Works

LOCATION _____

SURF. EL. _____ ROCK EL. _____ TD _____

Casing & Piezometer Record	DEPTH (FT.)	Stratig.	SOIL SAMPLE RECORD: Samp. No.	Sample per 6"	Samp. Type	Progress (Date)	DRILLING RECORD: Type Bit	Run No.	No. of Seg.	Recov (Ft.)	% Rec	RQD	INSPECTOR'S REMARKS: Pocket penetrometer, water loss, artesian cond., caving, void, etc.	GEOLOGIST'S LOG
Perf	100													(continued) GRAVEL SOME FINES (SAND)
	106													GRAVEL CLAY CONTENT
Perf														
	125													Boring Completed at 120 feet
	150													
	175													
	200													

A-7

⊗ Show diameter, depth casing(s), depth perforations piezometer. Indicate method advancing hole through soil.

Diameter (s) Sampler (s) _____

Weight Sampler Hammer _____ Drilling Fluid Soil _____ Rock _____

Free Drop Sampler Hammer _____

SWEET, EDWARDS & ASSOCIATES, INC.

GROUND WATER RECORD

Depth to Water	Time	Date	Depth of Casin

CONTRACTOR American Drilling and Development, Inc.
DRILLER _____ HELPER _____
INSPECTOR _____ LOGGER _____ (Soil) _____ (Rock)
DATE: HOLE BEGUN 10/13/79 CASING PULLED _____ LOG _____ (Soil) _____ (Rock)

PROJ. NO. _____ BORING NO. 5 SH 1 OF 2
PROJ. NAME Kaiser Aluminum Trentwood Works
LOCATION Spokane (SW¼ NE¼ Sect 11 T25N R 44E)
SURF. EL. _____ ROCK EL. _____ TD 120'

Casing & Piezometer Record	DEPTH (FT)	Stratig.	SOIL SAMPLE RECORD: Samp. No.	Blows per 6"	Samp. Type	Progress (Date)	DRILLING RECORD: Type Bit	Run No.	No. of Seg.	Recov (Ft.)	% Rec	RQD	INSPECTOR'S REMARKS: Packet penetrometer, water loss, artesian cond., caving, void, etc.	GEOLOGIST'S LOG
	0													GRAVEL AND SOIL BLACK ASH MATERIAL
														GRAVEL AND LARGE BOULDERS
	25													
														GRAVEL, COARSE
	50													
8" Ø														
	75													GRAVEL AND SAND
Perf-orated		▽											Water first encountered at 90 feet	GRAVEL
Perf	100													GRAVEL, CLAY, MIXED

Ⓒ Show diameter, depth casing(s), depth perforations piezometer. Indicate method advancing hole through soil.

Diameter (s) Sampler (s) _____
Weight Sampler Hammer _____ Drilling Fluid Soil _____ Rock _____
Free Drop Sampler Hammer _____

SWEET, EDWARDS & ASSOCIATES, INC.

GROUND WATER RECORD

Depth to Water	Time	Date	Depth of Casing

CONTRACTOR _____

DRILLER _____ HELPER _____

INSPECTOR _____ LOGGER _____ (Soil) _____ (Rock)

DATE: HOLE BEGUN _____ CASING PULLED _____ LOG _____ (Soil) _____ (Rock)

PROJ. NO. _____ BORING NO. 5 SH 2 OF 2

PROJ. NAME Kaiser Aluminum Trentwood Works

LOCATION _____

SURF. EL. _____ ROCK EL. _____ TD 120'

Casing & Piezometer Record	DEPTH (FT.)	Strata	SOIL SAMPLE RECORD: Sample No.	Blows per 6"	Sample Type	Progress (Date)	DRILLING RECORD: Type Bit	Run No.	No. of Sag.	Recov (Ft.)	% Rec	RQD	INSPECTOR'S REMARKS: Pocket penetrometer, water loss, artesian cond., caving, void, etc.	GEOLOGIST'S LOG
Perf	100													GRAVEL, CLAY, MIXED
														COARSE GRAVEL
Perf														
	125													Boring Completed at 120 feet
	150													
	175													
	200													

A-9

Show diameter, depth casing(s); depth perforations piezometer. Indicate method advancing hole through soil.

Diameter (s) Sampler (s) Well diameter is 6 inch

Weight Sampler Hammer _____ Drilling Fluid Soil _____ Rock _____

Free Drop Sampler Hammer _____

SWEET, EDWARDS & ASSOCIATES, INC.

GROUND WATER RECORD

Depth to Water	Time	Date	Depth of Casing

APPENDIX B

STORET Data

Appendix B
from E.P.A., 1974

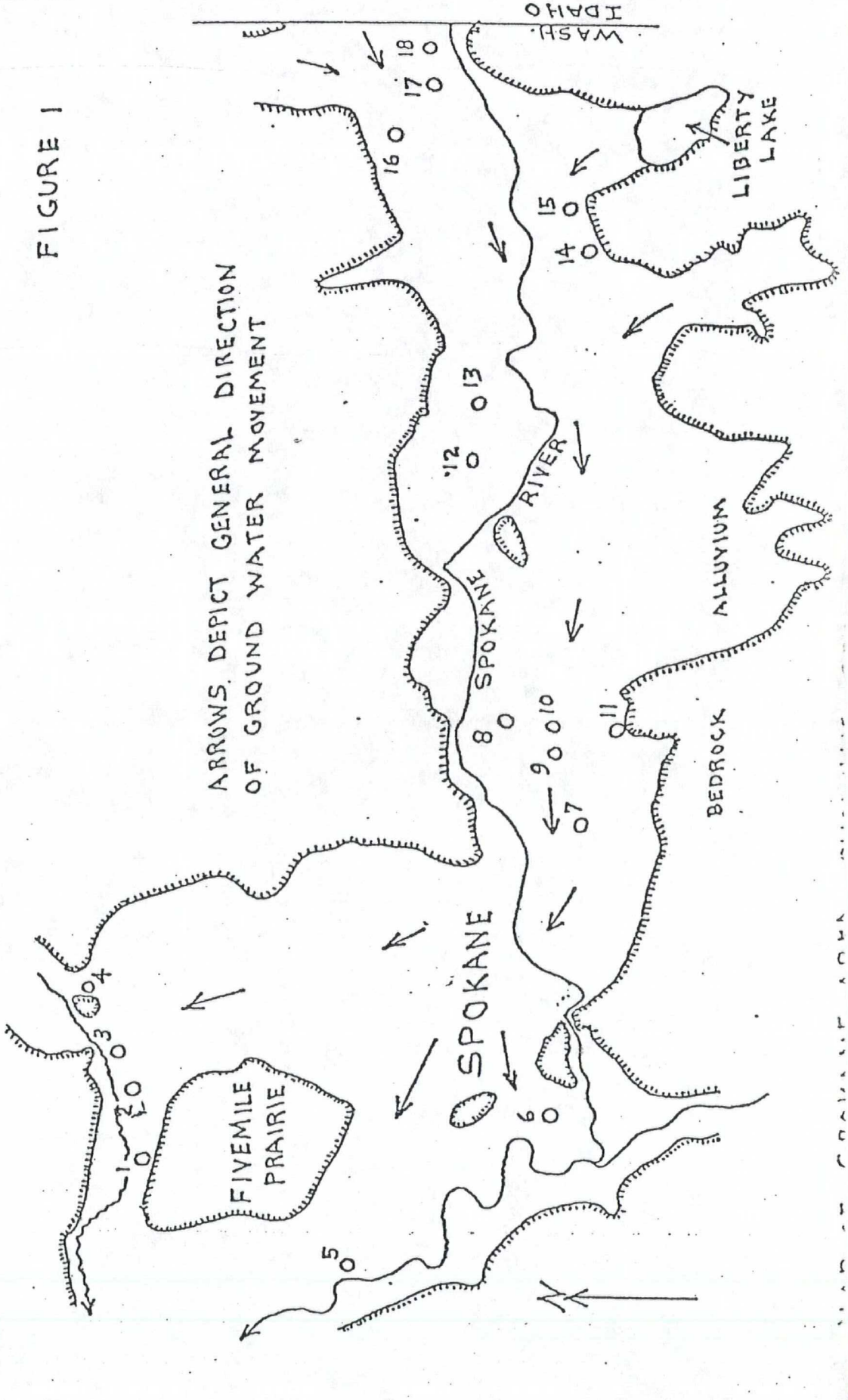


FIGURE 1

STORET RETRIEVAL DATE 74/11/19

12

25440202WASH 53630061
47 41 18.0 117 12 15.0
KAISER ALUM EASTGATE WELL
53 WASHINGTON
PACIFIC NORTHWEST
SPOKANE RIVER BASIN
GRDWATER 2111210
2 0129 FEET DEPTH

DESCRIPTION

WELL OWNER=KAISER ALUMINUM COMPANY EASTGATE WELL OWNERS #=

WELL LOCATION=SPOKANE COUNTY, SEC 2, T25N, R44E

TYPE WELL=DRILLED DEPTH OF WELL=129 FT DATE CONSTRUCTED=1942

ALTITUDE LAND SURFACE=2015FT DEPTH TO WATER=79 FT DATE MEAS=MAR 1942

AQUIFER=SPOKANE GRAVEL WATER USE=INDUSTRIAL

REMARKS=USGS # 201

STORET RETRIEVAL DATE 74/11/14

12

25440202WASH 53630061
47 41 18.0 117 12 15.0
KAISER ALUM EASTGATE WELL
53 WASHINGTON
PACIFIC NORTHWEST
SPOKANE RIVER BASIN
GRDWATER 2111210
2 0129 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00900 TOT HARD CACO3 MG/L	00902 NC HARD CACO3 MG/L	00410 T ALK CACO3 MG/L	38260 MBAS MG/L	32730 PHENOLS TOTAL UG/L	00915 CALCIUM CA,DISS MG/L	T.DS MG/L
73/06/27	14	35	2	10.2	7.60	336	150	5	146	0.03	7	39.0	175
73/09/25	13	00	2	9.5	7.90	320	150	4	145	0.05	0	40.0	174
	13	01	1										
73/12/18	11	40	2	9.5	7.90	357	170	18	147	0.02	0	43.0	197
74/03/20	11	05	2	9.5	7.50	590	190	28	160	0.10	0	49.0	329

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	00925 MGNSIUM MG,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00930 SODIUM NA,DISS MG/L	00931 SODIUM ADSBTION RATIO	00440 HCO3 ION HCO3 MG/L	00445 CO3 ION CO3 MG/L	00405 CO2 MG/L	00940 CHLORIDE CL MG/L	00950 FLUORIDE F,DISS MG/L
73/06/27	14	35	2	13.0	7.50	5.80	0.2	178	0		4	0.10
73/09/25	13	00	2	12.0	6.90	4.50	0.2	177	0		3	0.00
	13	01	1									
73/12/18	11	40	2	14.0	7.10	5.40	0.2	179	0	3.6	7	0.10
74/03/20	11	05	2	16.0	12.00	34.00	1.1	195	0	9.9	60	0.10

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	00945 SULFATE SO4-TOT MG/L	00620 NO3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	01000 ARSENIC AS,DISS UG/L	01025 CADMIUM CD,DISS UG/L
73/06/27	14	35	2	12	2.000	0.000	0.010	0.080	0.003	0.008	4	1
73/09/25	13	00	2	11	1.400	0.002	0.010	0.050	0.004	0.004	6	0
	13	01	1									
73/12/18	11	40	2	11	3.100	0.003	0.020	0.060	0.018	0.020	3	0
74/03/20	11	05	2	16	5.400	0.013	0.690	0.910	0.003	0.004	2	0

STORET RETRIEVAL DATE 74/11/14

25440202WASH 53630061
47 41 18.0 117 12 15.0
KAISER ALUM EASTGATE WELL
53 WASHINGTON
PACIFIC NORTHWEST
SPOKANE RIVER BASIN
GRDWATER 2111210
2 0129 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	01030 CHROMIUM CR,DISS UG/L	01040 COPPER CU,DISS UG/L	01046 IRON FE,DISS UG/L	01056 MANGNESE MN,DISS UG/L	01049 LEAD PB,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01090 ZINC ZN,DISS UG/L	39340 BHC WHL SMPL UG/L	39380 DIELDRIN WHL SMPL UG/L
73/06/27	14 35		2	0	9	40	0.0	3	0.0	360		
73/09/25	13 00		2	0	3	20	0.0	5	0.1	60	0.001K	0.001K
	13 01		1									
73/12/18	11 40		2	0	4	60	0.0	0	0.0	80		
74/03/20	11 05		2	30	4	10	0.0	1	0.0	90		

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	39390 ENDRIN WHL SMPL UG/L	39400 TOXPHENE WHL SMPL UG/L	39410 HCHLR WHL SMPL UG/L	39350 CHLRDANE WHL SMPL UG/L	39360 DDD WHL SMPL UG/L	39365 DDE WHL SMPL UG/L
73/06/27	14 35		2						
73/09/25	13 00		2						
	13 01		1	0.002K	0.060K	0.001K	0.005K	0.001K	0.001K
73/12/18	11 40		2						
74/03/20	11 05		2						

STORET RETRIEVAL DATE 74/11/19

```
 2544010 1WASH     53630060
47 41 35.0 117 10 34.0
SPOKANE IND PARK WELL #2
53        WASHINGTON
PACIFIC NORTHWEST
SPOKANE RIVER BASIN
GROUNDWATER                    2111210
2                         0160 FEET  DEPTH
```

13

DESCRIPTION

WELL OWNER=SPOKANE INDUSTRIAL PARK OWNERS #=2

WELL LOCATION=SPOKANE COUNTY, SEC 1, T25N, R44E

TYPE WELL=DRILLED DEPTH OF WELL=160 FT DATE CONSTRUCTED=

ALTITUDE LAND SURFACE=2050FT DEPTH TO WATER=64 FT DATE MEAS=MAY 1951

AQUIFER=SPOKANE GRAVEL WATER USE=INDUSTRIAL

REMARKS=USGS # 131

STORET RETRIEVAL DATE 74/11/14

13

2544010 1WASH 53630060
47 41 35.0 117 10 34,0
SPOKANE IND PARK WELL #2
53 WASHINGTON
PACIFIC NORTHWEST
SPOKANE RIVER BASIN
GRDWATER 2111210
2 0160 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	00010 WATER TEMP CENT	00400 PH SU	00095 CNDUCTVY AT 25C MICROMHO	00900 TOT HARD CACO3 MG/L	00902 NC HARD CACO3 MG/L	00410 T ALK CACO3 MG/L	38260 MBAS MG/L	32730 PHENOLS TOTAL UG/L	00915 CALCIUM CA,DISS MG/L	TDS MG/L
73/06/27	15 00		2	10.6	7.70	284	140	5	136	0.00	0	35.0	160
73/09/25	12 30		2	10.5	7.90	297	150	3	143	0.06	0	37.0	160
	12 31		1										
73/12/18	12 20		2	10.0	7.90	325	160	16	148	0.01	0	41.0	177
74/03/20	10 00		2	9.6	7.60	293	140	6	135	0.10	0	35.0	166

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	00925 MGNSIUM MG,DISS MG/L	00935 PTSSIUM K,DISS MG/L	00930 SODIUM NA,DISS MG/L	00931 SODIUM ADSBTION RATIO	00440 HCO3 ION HCO3 MG/L	00445 CO3 ION CO3 MG/L	00405 CO2 MG/L	00940 CHLORIDE CL MG/L	00950 FLUORIDE F,DISS MG/L
73/06/27	15 00		2	13.0	1.70	3.60	0.1	166	0		2	0.10
73/09/25	12 30		2	13.0	1.90	3.00	0.1	174	0		1	0.00
	12 31		1									
73/12/18	12 20		2	15.0	2.00	3.90	0.1	181	0	3.6	1	0.20
74/03/20	10 00		2	13.0	1.90	3.30	0.1	164	0	6.6	1	0.20

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	00945 SULFATE SO4-TOT MG/L	00620 NO3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	01000 ARSENIC AS,DISS UG/L	01025 CADMIUM CD,DISS UG/L
73/06/27	15 00		2	11	0.810	0.001	0.010	0.050	0.002	0.010	3	0
73/09/25	12 30		2	10	0.710	0.003	0.010	0.030	0.007	0.008	4	0
	12 31		1									
73/12/18	12 20		2	11	2.100	0.002	0.010	0.080	0.008	0.008	4	0
74/03/20	10 00		2	11	0.820	0.001	0.030	0.400	0.003	0.005	3	0

STORET RETRIEVAL DATE 74/11/14

25440101WASH 53630060
47 41 35.0 117 10 34.0
SPOKANE IND PARK WELL #2
53 WASHINGTON
PACIFIC NORTHWEST
SPOKANE RIVER BASIN
GRDWATER 2111210
0160 FEET DEPTH

13

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	01030 CHROMIUM CR,DISS UG/L	01040 COPPER CU,DISS UG/L	01046 IRON FE,DISS UG/L	01056 MANGNESE MN,DISS UG/L	01049 LEAD PB,DISS UG/L	71900 MERCURY HG,TOTAL UG/L	01090 ZINC ZN,DISS UG/L	39340 BHC WHL SMPL UG/L	39380 DIELDRIN WHL SMPL UG/L
73/06/27	15 00		2	0	10	60	0.0	2	0.2	30		
73/09/25	12 30		2	0	16	20	0.0	3	0.0	20	0.001K	0.001K
	12 31		1									
73/12/18	12 20		2	0	2	0	0.0	0	0.0	0		
74/03/20	10 00		2	0	5	10	50.0	1	0.0	20		

DATE FROM TO	TIME OF DAY	DEPTH FEET	00028 ANALYZE AGENCY CODE	39390 ENDRIN WHL SMPL UG/L	39400 TOXPHENE WHL SMPL UG/L	39410 HCHLR WHL SMPL UG/L	39350 CHLRDANE WHL SMPL UG/L	39360 DDD WHL SMPL UG/L	39365 DDE WHL SMPL UG/L
73/06/27	15 00		2						
73/09/25	12 30		2					0.001K	0.001K
	12 31		1	0.002K	0.060K	0.001K	0.005K	0.001K	0.001K
73/12/18	12 20		2						
74/03/20	10 00		2						